WAP-BASED PERSONALISED HEALTH CARE SERVICES

S. Petsas[1], D. Tzovaras[1], L. Makris[1], M. G. Strintzis[1,2]
[1]Informatics and Telematics Institute, Thessaloniki, Greece
[2]Department of Electrical and Computer Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract- **This paper presents a new approach in the field of mobile access to web-based health-care services. Specifically, a web-based health-care system was designed and implemented to support not only web-access but also mobile access through the use of the WAP protocol. Personalized access to the system is also supported in both Web and WAP based access tools. Application screenshots of the developed application are presented in the results section of the paper.**

Keywords **- WAP, mobile, health-care.**

I. INTRODUCTION

This paper presents a new approach in the field of mobile access to web-based health-care services [1]. During the last years, more and more modern tools have found their ways to the different tasks during the design, the realization and data processing in the area of mobile access to e-health services. Choosing tools depends on a variety of conditions and aspects that have to be considered [1],[2].

The Wireless Markup Language (WML) offers the possibility of using handheld devices like mobile phones (handy) or Personal Digital Assistants (PDA) for remote data entry. These widespread, easy to use hardware devices can have wireless access to the standard Internet for use in their applications. This combination seems to become a success because of the existing infrastructure, the ongoing efforts in improving and enlarging the Internet platform and also because the approach is so similar to the well accepted World Wide Web (WWW). As of today this technology has not yet matured, different issues have to be discussed prior to choosing hard- and software for application in clinical trials. We will show some aspects related especially to modern handheld devices and the belonging software.

The costs of clinical trials during development and introduction of a new drug are immense. Legal and ethical aspects demand for efficient processes during these phases of research. One category of tools to support trials is remote data entry (RDE). For a long time RDE systems are used successfully within multi center clinical trials as the front end for gathering data at different locations. This is accomplished mainly with ordinary PC systems, connected to the Internet. During the last months new generations of mobile systems (GPRS, UMTS) could be found in the news. Of course the question of using the new technology in ordinary trial systems has to be discussed.

The present paper presents the design and implementation of a system providing personalized access of mobile devices like personal digital assistants (PDA) or cellular phones to a web-based health-care system. The architecture of the proposed system is graphically shown in Fig. 1.

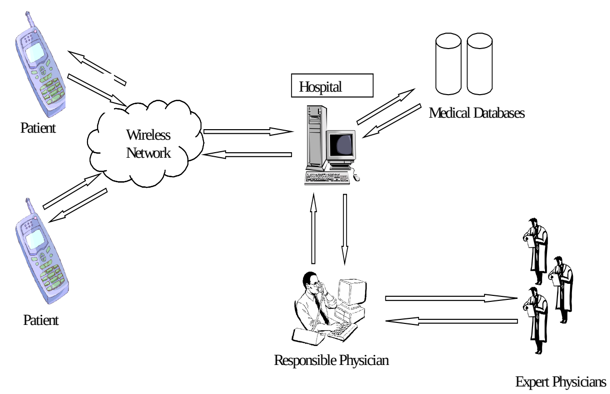


Fig. 1.Proposed system architecture.

The paper is organized as follows. Section II presents the features of the web-based health care monitoring system. The features of the WAP-based access to the aforementioned web-based health care system are examined in Section III. Application screenshots, demonstrating the performance of the proposed system, are presented in Section IV and conclusions are drawn in Section V.

II. WEB-BASED HEALTH CARE MONITORING SYSTEM

Making our design decisions on the implementation of our demonstrator brought us to the dilemma of whether to use commercially available software or to use the wide selection of software that the open source community offers. Our main concern was to build a system that could be easily deployed regardless of the software platform it run on. We, finally, chose the open source option since this would give us the opportunity to develop a system that could be used either on a Win32 or a Unix platform while keeping set up costs to the minimum.

For the required three-tier architecture we needed to choose between the available options for a Web Server, an Application Server and a Database Server. Apache (http://www.apache.org/) was the unchallenged choice for the Web Server, PHP (http://www.php.net/) was chosen as the server side scripting language while MySQL (http://www.mysql.com/) was selected as the proper RDBMS to support our storage requirements.

Report Documentation Page

Report Date 25OCT2001	Report Type N/A	Dates Covered (from... to) -

Title and Subtitle Wap-Based Personalised Health Care Services	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Informatics and Telematics Institute, Thessaloniki, Greece	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) US Army Research Development & Standardization Group (UK) PSC 802 Box 15 FPO AE 09499-1500	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes Papers from the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, October 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on CD-ROM., The original document contains color images.	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 4	

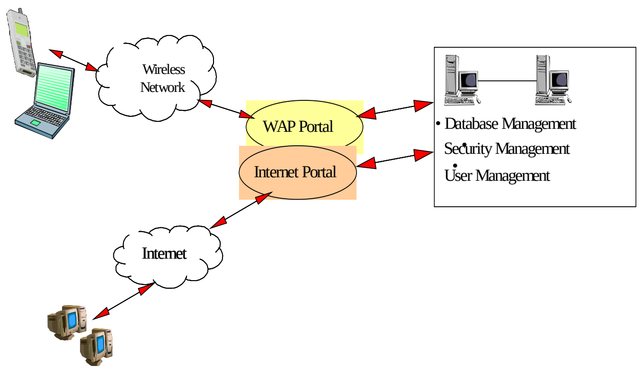


Fig2: Web-based health care system.

PHP is an HTML-embedded scripting language similar in its concept to Microsoft's ASP and Allaire's Cold-Fusion. When a client requests a PHP page the Web Server passes this request to PHP, which in turn generates dynamically (possibly based on information drawn from a database) the web page to be sent back to the client. Much of its syntax is borrowed from C, Java and Perl with a couple of unique PHP-specific features thrown in. Anyone with a minor experience on the above-mentioned programming languages will feel right at home. MySQL is an open source project of T.c.X. DataKonsultAB and is distributed under the GPL license. MySQL is a fast, ANSI SQL92 compliant, RDBMS system, which is unrivalled in its ease of use.

Although MySQL is an ideal tool for the support of a Web application we didn't want to be bound to its use for our system. PHP does not support the abstraction we needed for database access and we didn't want to use ODBC, which is sometimes difficult to set up on Unix systems. Instead we developed a wrapper for the MySQL database functions of PHP (an MS SQL wrapper is under development). This layer provides a unified database interface to our system while it speaks to the database using database specific PHP functions. One has only to develop this database specific wrapper in order to support a different database system.

Our other concern was that we wanted to build a presentation layer that could be used to produce both HTML and WML in order to support access for traditional web browsers and modern WAP devices. We chose a template driven approach so that we could separate the application logic from its presentation.

In Figure 3 we present the system components of the web-based health-care system. A typical request would be passed from the Web Server to the Core Application Logic. The Core Application Logic would then communicate with the Database Server, if needed, through the Database Abstraction Layer, prepare the data to be presented and send it to the Presentation Layer. Based on the Agent Type the Presentation Layer would choose the correct template, format the result and pass the final page to the Web Server. Finally the Web Server would convey the response to the Client (Web or WAP Browser). Figure 4. presents a typical screen of the final Web application.

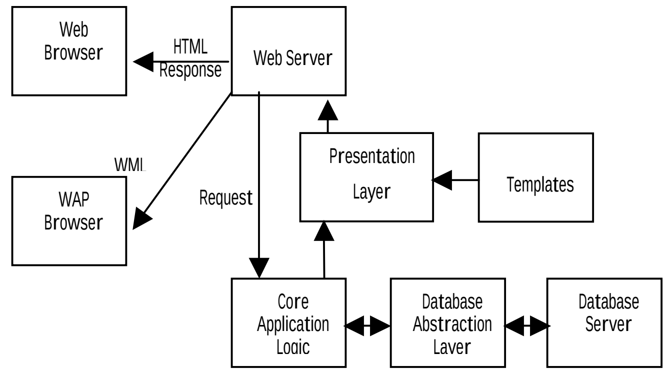


Fig.3 : System components of the Web-based health-care system.

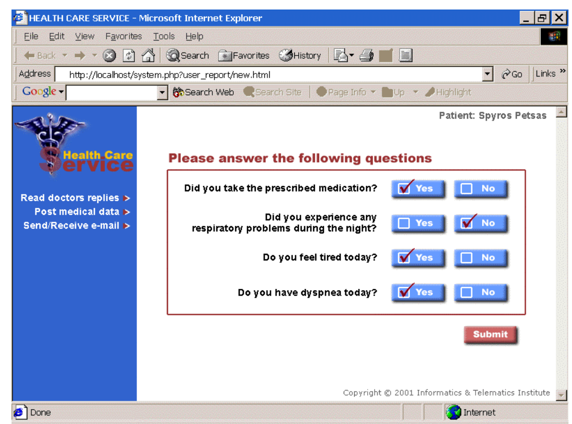


Fig.4 : A typical screen of the Web-based health-care system.

III. WAP-BASED ACCESS TO WEB HEALTH CARE SERVICES

WAP is an industry-wide specification for developing applications that operate over wireless communication networks [3]. It is a single, open standard that has been developed by some of the world's leading wireless telecommunications companies in a democratic consortium known as the WAP Forum. The WAP Forum states that WAP is "an open, global specification that empowers mobile users with wireless devices to easily access and interact with information and services instantly" [4].

WAP empowers companies and individuals to make the information found on the Internet available to mobile users by transforming this information into WAP pages. This means that users of WAP-enabled phones can access such interactive services.

WAP is targeted at various types of handheld devices, including mobile phones, Personal Data Assistants (PDAs) and pagers. Because of this, the protocols contained in WAP have been optimized to overcome the challenges posed by

these devices, such as limited display capabilities, narrow bandwidth, limited processing power, and limited memory and CPU usage. WAP does not make any assumptions about the target client other than their size and bandwidth limitations.

WAP is presently the only available specification for wireless communication. However, the next generation of wireless specifications and protocols are already being developed, and it is envisaged that, with increases in bandwidth not being too far into the future.

WAP is designed to be flexible enough to run over a wide range of wireless bearer networks (including GSM, CDMA, TDMA and PDC). Content and applications are sent to WAP-enabled phones via a WAP Gateway, which is a software entity within the mobile network that connects to the Internet/Intranet.

A. Implementation of the WAP-based system

In Figure 4, starting from the left, you'll find the mobile WAP device attached to the mobile network (GSM, CDDA, etc) which dials the modem attached to a dial-in server (RAS, or Remote Access Service). This server gives the WAP device access to the protocols it needs. These are the same lower level protocols as a normal Internet Service Provider will give you. This is known as PPP or Point-to-Point Protocol.

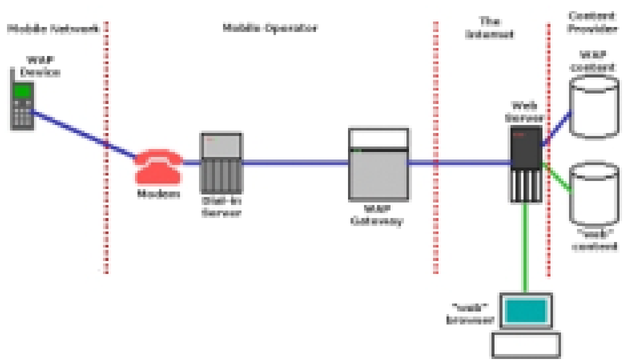


Fig.4 : System components of the WAP-based health-care system.

These protocols are used to access the next step in the chain, the WAP gateway, in this figure hosted by the mobile operator. The WAP gateway is the link between the wireless and the "web" world, basically giving the WAP device access to the common Internet.

Another way of explaining it, and in a bit more detail would be to say that when you type in the URL for a site on your WAP device, for instance http://wap-med.iti.gr/ the WAP device first checks if it already has an open connection, if not it dials up the PPP provider as described above. After the PPP provider has given the WAP device the required protocols and assigned it an IP address, the request for the URL is sent to the gateway. The WAP gateway, now under "control" of the WAP device requests the URL with a normal HTTP request, such as GET http://wap-med.iti.gr/. On the internet, there is a normal "web" server which in this case holds both WAP and "web" contents, which now receives the request to send out the contents located at the http://wap-med.iti.gr/ URL. Also note the normal "web" browser at the lower part of the figure. The web server, depending on which type of browser it is talking to (WAP or "web"), sends out WAP, represented by the blue line, or "web" content represented by the green line.

Following the requested content back to the WAP device, the contents, if they are in so called textual WML code (the human readable type) [5], the WAP gateway compiles the textual WML into so called tokenized WML, or WMLC, where basically the code is "compressed" down into binary data (the machine readable type). This tokenized WML is then passed back to the WAP device. If the contents from the webserver are already in tokenized WML format, the WAP gateway skips this operation. The reason for the conversion from textual WML to tokenized WML is to reduce bandwidth usage. A WAP device's WML browser can only read tokenized WML.

Finally, back at the WAP device that requested the URL, the WML browser, when receiving the tokenized WML code renders the contents on the WAP device's display to present a card for the user.

B. Security of the WAP Access system

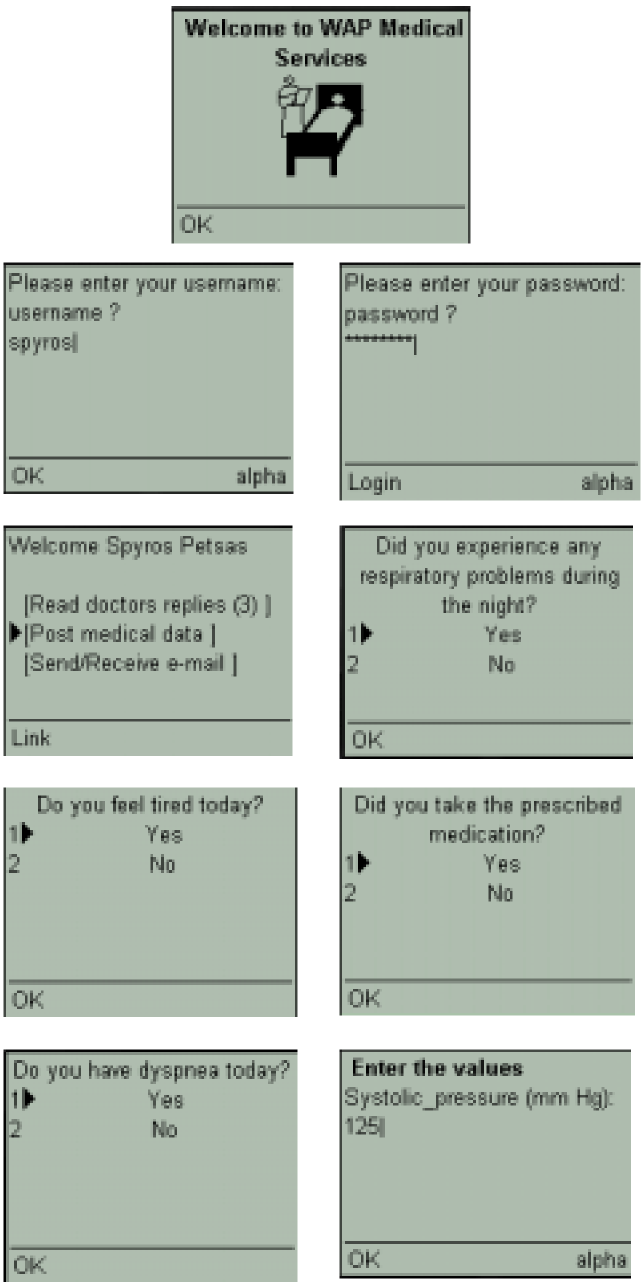
The issue of security dominates e-health applications and represents new challenges in assuring both patients and physicians that they are operating in a secure environment. Some of the basic elements of security, such as confidentiality, authentication and integrity are addressed by WTLS. WTLS, which is similar to Transport Layer Security (TLS) and Secure Sockets Layer (SSL), provides encryption and authentication for server-to-client security. This prevents fraudulent access to WAP transactions and opens the way for wireless e-health applications.

The primary goal of the WTLS layer is to provide privacy, data integrity and authentication between two communicating applications. WTLS provides the upper-level layer of WAP with a secure transport service interface that preserves the transport service interface below it. In addition, WTLS provides an interface for managing (for example, creating and terminating) secure connections. WTLS is based on the Internet security standard TLS/SSL but differs in that it supports datagram transports (e.g. UDP) and uses an optimized handshake and data structures. The WTLS protocol is optimized for low-bandwidth bearer networks with relatively long latency.
However, to fully participate in e-health care services, the additional security elements of authorization and non-

repudiation must be addressed, in particular, Public-Key Infrastructures (PKIs). In the present paper, the conversion between the SSL encryption (used by Web) to the WTLS encryption (used by WAP) in order to offer the required security for the transmission of medical data was implemented as part of the WAP gateway.

III. RESULTS

The following application screenshots were taken by the proposed system indicating the communication of a patient with the system



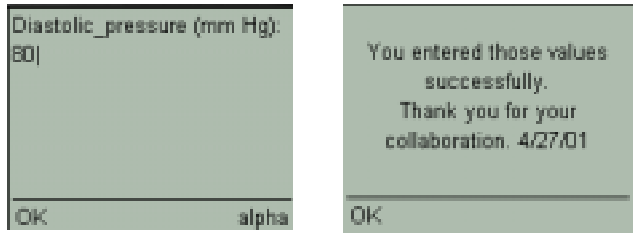


Fig. 5.Application screenshots.

Based on the user input (via the use of his/her mobile phone) the physician is informed about the condition of his/her patients and also monitors and stores data related to the specific patient. Figure 6 shows the diagram shown to the physician based on the values entered by his patient.

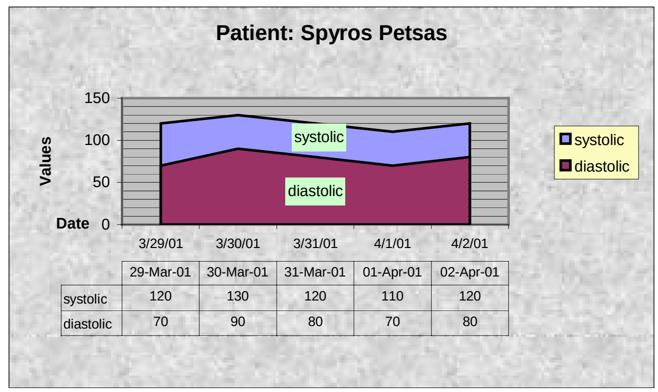


Fig. 6. Systolic and diastolic pressure diagram based on the values entered by his patient

ACKNOWLEDGMENT

This work has been supported by the Greek-Cyprus S&T Cooperation Project “Use of WAP for Mobile Access to Health Care Services”.

REFERENCES

[1] Eija Kaasinen, “Two Approaches to Bringing Internet Services to WAP Devices”, Computer Networks, Elsevier, Vol. 33, 2000, pp. 231-246.
[2] A. Pombortsis, “Communication Technologies in Health Care Environments”, International Journal of Medical Informatics, Elsevier, Vol. 52, 1998, pp. 61-70.
[3] “Wireless Application Environment Overview”, WAP Forum, http://www.wapforum.org.
[4] “Wireless Application Environment Specification”, WAP Forum, http://www.wapforum.org.
[5] “Wireless Markup Language Specification”, WAP Forum, http://www.wapforum.org.